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Working Paper on Chemical Warfare Agents and the Commercial Chemical Industry

1. Chemical agents, the effects of their use in warfare, and the possibility of subjecting such agents to arms control have been studied extensively in recent years. The reports of the United Nations Secretary-General, World Health Organization, and SIPRI have received worldwide attention. In addition, studies of this problem have been conducted by individual nations. The United States Government completed a thorough review of this subject in the Fall of 1969.

2. In considering the possibility of negotiating a new arms control agreement for chemical weapons, one of the areas which must be studied and understood is the relationship between the production of chemical agents for war and the production of chemicals for peaceful purposes by the commercial chemical industry. The chemical industry was in its infancy during World War I, when chemical warfare was first employed. Even so, in that conflict more than 100,000 tons of chemicals were produced for use as weapons, and 1,300,000 deaths and casualties were reported from the use of poison gas. Since World War I, many additional countries have developed a chemical industry, and the chemical production facilities of the more advanced countries have increased tremendously. In the 50 years since the end of World War I, for example, gross production of the worldwide chemical industry has increased in value from an estimated $5 billion to $150 billion, approximately a 30-fold increase. Between 1959 and 1969, world output of chemicals increased from an estimated $60 billion to $150 billion, and the magnitude of increase is continuing to accelerate.

3. Many of the chemicals which caused death and casualties in World War I are today produced in large quantities for industrial use. These chemicals might have military utility for states which may be unable, or might not desire, to manufacture or import modern nerve agents. For example, among the choking agents, which resulted in more than 80 per cent of the deaths by gas in World War I, phosgene is currently produced in a number of countries. Annual production figures are unknown, but in at least some of these countries, annual production is thought to exceed 100,000 tons.

Phosgene is a widely used raw material in the manufacture of synthetic plastics, insecticides, paints, and pharmaceuticals. Being easily liquified, industrial phosgene could be diverted relatively easily for use in war should a nation decide to employ it, without necessarily requiring sophisticated delivery systems.

4. Among the blood gases developed during World War I, hydrogen cyanide (hydrocyanic acid) is a valuable intermediate in the manufacture of many organic chemical compounds, including benzyl cyanide, acrylonitrile, and dyes. Its world production volume is believed to be in excess of 1 million tons annually. Hydrogen cyanide is currently being produced by the United States, 6 Western European countries, Japan, the USSR, and Communist China. Another blood gas which also finds widespread commercial use is cyanogen chloride. It was used in limited quantities in World War I and is presently used as a fumigant and industrial intermediate.

5. Mustard gas, which was the most effective chemical weapon developed in World War I, is produced very simply from ethylene-oxide. On a worldwide basis, over one million tons of ethylene-oxide are produced annually for use, inter alia, in manufacturing detergents and disinfectants. The improper disposal of commercial mustard gas intermediates by industrial users has led on several occasions to casualties among fishermen and bathers, and has resulted in charges that mustard gas itself was the cause of injury.

6. The everyday production of commercial materials relevant to chemical warfare in the United States, as in other industrially developed countries, is quite substantial. For example, there are 19 locations for phosgene production and 11 facilities for hydrogen cyanide production in the United States. These produce in total approximately 350,000 tons of phosgene and 200,000 tons of hydrogen cyanide per year for commercial purposes. Of course, if one looks back into the commercial production of basic raw materials (for example, ethylene, sulphur, and chlorine, which are ingredients for mustard gas), the problem is much larger and the facilities more extensive.

7. Chemical agents of the World War I type, even though they may be effective against an unprepared enemy, are considered by those who have studied chemical weapons to be much less effective than the more recently discovered "nerve agents." The G and V families of organophosphorus nerve agents were discovered in 1936 and 1955, respectively, in the course of research on new commercial pesticides. These agents are similar to commercial organophosphorus pesticides, widely used in agriculture, which have, in fact, caused human deaths in cases of misuse. Both the nerve gases and

these related pesticides inhibit the enzyme acetylcholinesterase, causing death from respiratory and circulatory failure.

8. In addition to the similarities between the end products, many intermediates such as phosphorus trichloride, phosphorus oxychloride, ethyl and isopropyl alcohol, and ammonia are common to the production of pesticides and nerve agents. All are common industrial chemicals. In the mid-1960's, annual production of organophosphorus pesticides in the United States alone was approximately 30,000 tons. Present United States output is approximately 65,000 tons of organophosphorus pesticides per year, produced in the facilities of 14 basic manufacturers. Elsewhere in the world, there are at least 50 plants involved in the production or formulation, or both, of commercial organophosphorus pesticides in a total of 12 countries, including countries of Western and Eastern Europe. The total world output of the entire organophosphorus pesticide industry is estimated to be in excess of 130,000 tons annually.

9. The basic technical information for production of nerve agents, including descriptions of the chemical processes and amounts of raw materials required, is in the public domain. Such production does not present any insurmountable technical difficulties, although the problem of maintaining safety for plant personnel is, in view of the deadly character of the agents, quite complex.

10. From the foregoing discussion, it can be seen that the capacity for producing chemical warfare agents grows out of, and is linked to the commercial chemical industry of a given country. The raw materials for various chemical warfare agents, and even some agents themselves, are produced in vast amounts in a great many locations throughout the world.